

Venting after phosphine fumigation

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Take home messages

- Venting grain after phosphine fumigation may take longer than the current label minimum recommended times. e.g. 1 day fan venting
- Applying the workplace phosphine safety limit of TWA 0.3 ppm, using the current testing method of 'spearing grain in truck' at delivery point, may need industry assessment
- During fumigation, grain absorbs small amounts of phosphine. It takes a number of days for the grain to desorb this gas to very low levels
- Augering grain into a truck immediately after fumigation, with no venting, only briefly removes phosphine gas from the intergrain spaces. Grain rapidly desorbs more phosphine gas
- Research presented in this paper is from only one trial (Feb. 2017) on wheat. There is very little field research data on venting phosphine fumigations. More research is required

Venting after phosphine fumigations - is there a problem?

In 2016 more than 70 truckloads of grain were rejected at the Port of Brisbane. They exceeded the 0.3 ppm phosphine gas concentration limit at delivery when grain was speared in the truck on the weighbridge.

The majority of the trucks rejected had phosphine gas concentrations in the range of 0.5 to 2.5 ppm. However a few had very high concentrations of 32, 82 and 440 ppm.

Grain load rejections for phosphine detections are also occurring at the Port of Melbourne and other grain receival sites, plus at a range of domestic grain buyers, such as stockfeed manufacturers, throughout Australia.

These grain rejections at the point of delivery are not only costly to individual grain growers and grain handlers, but this adds additional costs to Australia's grain logistics and export supply chain.

In the interests of employee safety at grain receival sites, businesses are apply the Workplace Safety standards for phosphine (PH3) using the TLV – TWA of 0.3 ppm.

The current method of testing when applying the TWA 0.3 ppm standard is to spear the grain in the truck on arrival and test gas concentrations within the grain before unloading.

Phosphine label - ventilation, what does it say?

Ventilation of structures is complete only when the phosphine concentration measured at appropriate locations in the enclosure and work area are below TLV – TWA exposure standard 0.3 ppm.

Following are minimum vent periods and may need to be increased to ensure standards (0.3 ppm) is not exceed:

Structures, including bunker storages:

- Not less than 1 day: with throughflow and forced draught (flash-proof fan)
- 2 – 5 days: with throughflow and natural draught (wind). Structures 300 tonnes or greater, 2 – 5 days depending on size. Structures less than 300 tonnes capacity, 2 days
- Not less than 5 days: without throughflow (i.e. access only through the headspace)

Applying the TWA workplace safety standard:

The grains industry in conjunction with the appropriate National & State, Work place health & safety authorities should clarify the interpretation and practical application of the TLV – TWA 0.3 ppm standard. In particular the wording - “phosphine concentrations measured at appropriate locations in the enclosure and work area”.

Is the current practice of measuring phosphine gas concentrations ‘within the grain bulk’ in the truck prior to unloading, an “appropriate location and work area” when apply the 0.3 ppm TWA worker safety standard?

A definition of TWA: “The TWA exposure value is the average airborne concentration of a particular substance when calculated over a normal 8 hour working day for a 5 day working week.”

So a worker is not to have an average phosphine exposure of greater than 0.3 ppm for 8 hours per day, for 5 days per week (40 hour week).

Stamp out poor, illegal practices

For the sake of Australia’s grains industry reputation, safety and using phosphine the way it should be used to control pests, the following practices by a small minority must be stopped:

1. Growers & commercial grain facilities – “not venting” after fumigations, augering straight into trucks for delivery
2. “Short”, last minute fumigations in the back of trucks before delivery. Not following label fumigation or venting times
3. Placing phosphine tablets directly into the grain, so tablet dust remains in grain
4. Truck drivers adding phosphine tablets to loads at some point during the delivery

Ventilation research - wheat 2017

In February 2017, phosphine fumigations on wheat were conducted in two small research silos (35 tonnes capacity) at the Hermitage research facility Warwick by Department of Primary Industry & Fisheries Qld Postharvest researchers.

Following standard phosphine fumigations (1.5 g / m³) for 7 days in “Silo A” and 10 days in “Silo B”, top lids where opened and aeration fans turned on for post fumigation ventilation for 1 day (24 hours).

The phosphine gas concentrations in Silo A are shown in Fig. 1 after a 7 day fumigation and 1 day (24 hours) ventilation period, with 20 hours of fan run time.

Phosphine gas concentrations in Silo A prior to ventilation commencing was 980 ppm approximately in all areas within the silo.

The yellow arrow indicates where the 1 day ventilation period has finished and gas measurements in grain have started. Gas sample tubes placed in the silo provided measurements points in grain at three locations, top, middle and bottom. The first gas readings were taken one hour after the ventilation fan was turned off.

The blue arrow indicates the point where the 35 tonnes of wheat was augered out of the silo and into a truck, then within one hour augered back into the silos. After one hour, gas readings were once again measured in grain.

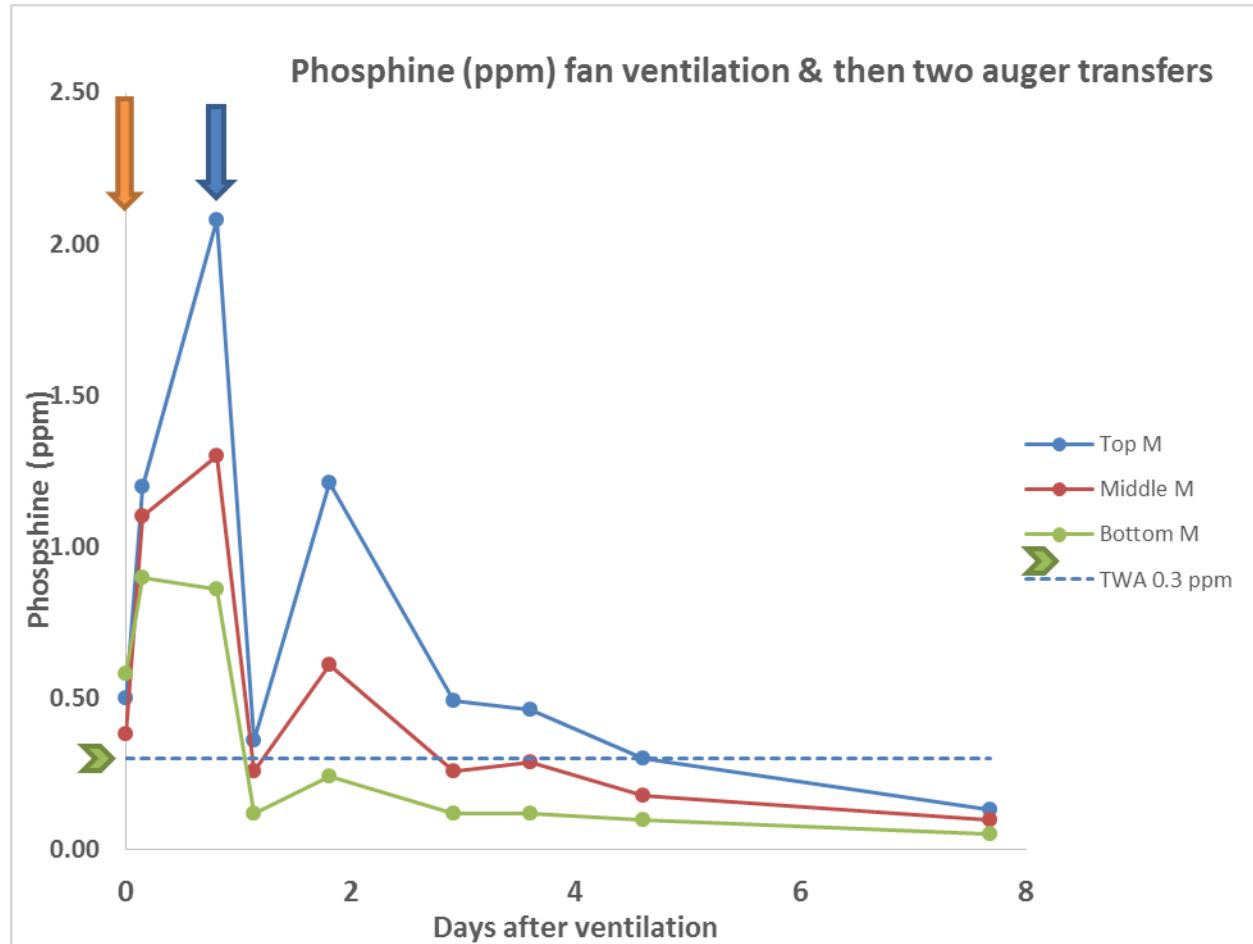


Fig. 1 Phosphine gas conc. in wheat after 1 day fan ventilation, followed by two auger tranfers

Research findings - Silo A

- Within 1 to 2 hours after a 1 day fan ventilation, wheat kernels “desorbed” phosphine back into the intergrain spaces bringing gas concentrations from zero back up to 0.4 - 0.6 ppm.
- 24 hours after ventilation was completed phosphine gas concentrations within the grain bulk had risen to 0.8 – 2.0 ppm
- One day after venting wheat, it was augered into a truck and then augered back into the silo. Gas reading 20 hours after twice augering went from zero to 0.2 – 1.2 ppm
- Wheat kernels are still desorbing phosphine over a number of days beyond a 1 day fan ventilation, bring concentrations well over 0.3 ppm

Phosphine gas in the grain bulk compared to surface

With the aim of having an initial look at the safety risk of working around grain that has been fumigated and vented for 1 day (24 hours fan run time), grain at the top of "Silo B" (10 day fumigation) was tested for phosphine gas concentrations in the grain bulk and at the grain surface.

Using a 1 meter 'spear', gas readings were taken at a depth of 1 meter in the grain at the top of the silo and at the same time, gas reading on the grain surface were recorded. See Fig. 2.

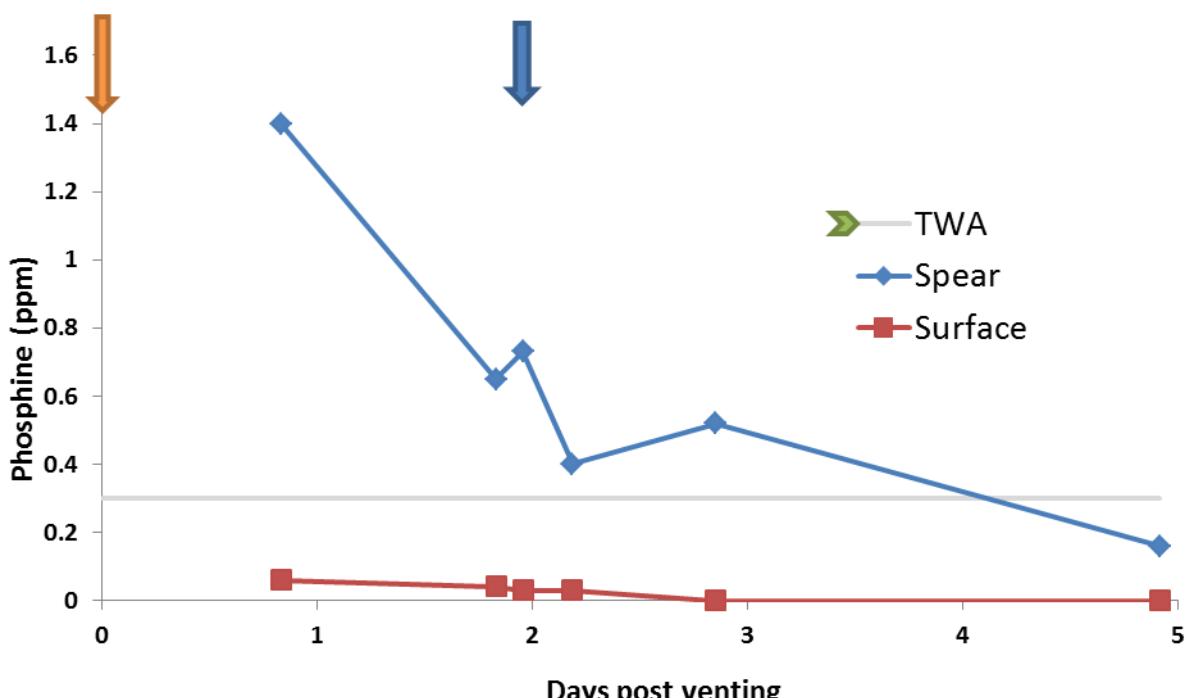


Fig. 2 Phosphine gas conc. in wheat after 1 days ventilation, at 1m depth and on the grain surface

Research findings - Silo B

- After 20 hour post venting (24 hours fan run) phosphine gas conc. in grain at a depth of 1 m in the top of the silo went from zero back up to 1.4 ppm. Similar to gas levels in Silo A.
- However, at the same time gas readings of 1.4 ppm are measured in the grain bulk, the gas concentrations on the surface of the grain were much lower - 0.06 ppm
- Phosphine gas concentrations on the grain surface after 1 day venting are well below TWA 0.3 ppm

Research summary

1. More research is required on wheat and other grains to draw reliable conclusions as there is very little field research data available on phosphine gas concentrations after venting
2. Wheat can desorb phosphine gas for a number of days beyond a 1 day fan ventilation
3. We require field research and clarification of what is the appropriate industry 'testing method' that is best suited to access compliance to the TWA 0.3 ppm phosphine safety standard

Further reading

- GRDG Factsheet – “Grain Fumigation – a guide” <http://storedgrain.com.au/fumigation-guide/>
- GRDC booklet – “Fumigating with phosphine, other fumigants and controlled atmospheres” <http://storedgrain.com.au/fumigating-with-phosphine-and-ca/>

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